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Religiosity, Knowledge of Evolution, and Political Ideology as Predictors of Attitudes Towards the Evolution v. Creationism Controversy

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RELIGIOSITY, KNOWLEDGE OF EVOLUTION, AND POLITICAL IDEOLOGY AS PREDICTORS OF ATTITUDES TOWARDS THE EVOLUTION V. CREATIONISM CONTROVERSY

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CHAPTER ONE

INTRODUCTION

Background

Darwin (1859/2009) published *On the Origin of Species* over 150 years ago. His core ideas (e.g., natural selection, common ancestry, ect.) have been "confirmed to such a degree that it would be perverse to withhold provisional assent" (Gould, 1983, p.255), especially after the "modern synthesis" (e.g., Huxley, 1942/2010) of genetics and evolutionary theory. As Dobzhansky (1973) famously stated, "Nothing in biology makes sense except in the light of evolution." Not surprisingly, 97% of scientists agree that life evolved over time; 87% think evolution occurred solely through natural processes, such as natural selection (Leshner, 2009).

In accordance with practically unilateral support for evolution among scientists, national-level policy for science education consistently emphasizes the importance of evolution for understanding biology (e.g., National Academy of Sciences, 1998, 2008; National Research Council, 1996). For example, the National Academy of Sciences (1998) advises teachers to "use evolution as the organizing theme in teaching biology."

Evolution's public bane, creationism, and its offshoot, Intelligent Design, are not science (see for example *Kitzmiller*, 2005), and proponents of teaching these so-called alternatives to evolution have lost every major federal court case in the last 40 years (Superfine, 2009). Yet, a recent report by Berkman and Plutzer (2011) of the National

Survey of High School Biology Teachers found that adherents of national policy guidelines are in the minority. A nationally representative probability sample of 926 biology teachers were asked whether they advocated, in class, for evolution, creationism, or neither; a mere 28% reported advocating for evolution. That left 13% advocating creationism and a “cautious 60%” that refused to explicitly advocate for either side while teaching. The researchers indicated that the “cautious 60%” oftentimes stayed on the fence in an attempt to avoid controversy. The researchers further indicated that advocates for evolution were more likely to have completed a course on evolution, and, simply put, teachers seemed to be ignoring education policies and teaching whatever they personally believed.

Outside of the high school classroom, nearly half of Americans flatly reject evolution, and far less than half actually concede to the sort of biological evolution Darwin and company have been researching for the last century and a half (Leshner, 2009). In the last 10 years, between 12% and 29% of survey respondents report they believe evolution via natural processes, such as natural selection (Plutzer & Berkman, 2008). In a recent Gallup survey (Newport, 2009) reported on Darwin's 200th birthday, 61% of respondents did not believe in evolution (25%) or had no opinion either way (36%). Lastly, in a survey of 34 developed countries (Miller, Scott, & Okamoto, 2006) the Unites States ranked 33rd—that is, second to last—in public acceptance of evolution.

Additionally, many people perceive that accepting evolution will lead to negative consequences. For example, Brem, Ranney, and Schindel (2003) found that both people who accepted evolution and those who believed in creationism perceived negative personal and social consequences to belief in evolution, such as increased selfishness and racism, and a decreased sense of purpose. This finding is fairly ironic and indicates low levels of familiarity with evolutionary theory, given that race is a biologically meaningless concept (Livingston & Dobzhansky, 1962; this fact is borne out of and supported by evolutionary theory) and, furthermore, evolutionary theory is being used to explain unselfishness and cooperation (e.g., de Waal, 2009) rather than preclude it.

The disparity between the scientific consensus and public controversy over evolution merits inquiry. This thesis proposes to first examine the determinants of people's beliefs about the history of life (Part 1). Second, it will examine how these beliefs affect whether people think evolution should or should not be taught in science class, as well as potential mediators of this relationship (Part 2). Lastly, it will explore the effects of a message advocating for teaching evolution in science class (Part 3).

Part One: Origin Beliefs

Two major factors readily lend themselves from the literature for explaining people's beliefs about, and acceptance of, evolution: knowledge of evolution and religiosity.

Knowledge of Evolution

The evidence for, and explanatory power of, evolutionary theory are indeed so overwhelming that it persuaded the field's own experts, hence it is therefore intuitive and in fact parsimonious to hypothesize that knowledge of evolution should predict acceptance of evolution. This was the sentiment of the renowned paleontologist and popularizer of evolution, Stephen Jay Gould, when he wrote, "Why has Darwin been so hard to grasp?... The difficulty cannot lie in complexity of logical structure, for the basis of natural selection is simplicity itself" (1973, p. 11). The relationship between knowledge and acceptance of evolution, however, has been difficult to find, as the following review demonstrates.

Only a handful of available studies have measured both knowledge and acceptance of evolution, and here, results have been quite mixed (Nehm & Schonfeld, 2007). Among the first to examine the relationship between were Bishop and Anderson (1990), who found that the amount of previous biology taken and pre- and post-test performance on an open-ended knowledge measure were unrelated to belief in evolution. They did find, however, moderate gains in pre- to post-test knowledge of evolution. This null effect was replicated in similar fashion by Cavallo and McCall (2008), who additionally found no significant changes in belief as a result of instruction, despite gains in knowledge. Demastes, Settlage, and Good (1995) found no effect of prior biology or science coursework on belief in evolution, and that students' use of "scientific or nonscientific conceptions" for understanding evolution had no effect on acceptance of evolution. Lord and Marino (1993), Brem, Ranney, and Schindel (2003), and Nadelson and Sinatra (2010) also found no relationship between students' understanding and acceptance of biological evolution; Sinatra, Southerland, McConaughy, and Deamstes (2003) found that knowledge was related to neither acceptance of human nor animal evolution. Similarly, Dole, Sinatra, and Reynolds (1991) found no relation between students' ability to understand a text on evolution and their stated belief in creationism (see also Walker, Hoekstra, & Vogl, 2002).

However, other studies have obtained positive effects. Lawson and Worsnop (1992) did find that instruction had no overall effect on belief, but that some specific changes in beliefs about evolution did occur from pre- to post-test. They interpreted this as suggesting that many students felt that evolution had indeed occurred, but that a special, creative force was needed to get life started. Unlike previously mentioned studies, pretest knowledge correlated significantly with pretest beliefs in evolution ($r=.33$, $p<.001$), and posttest knowledge correlated significantly with posttest belief ($.20$, $p<.05$). Strangely, pre- to post-test knowledge gains did not relate to belief change ($r=-.17$, $p=ns$). In a study of natural history museum visitors, MacFadden, Dunckel, Ellis, et al. (2007) found that 30% of respondents correctly invoked natural selection during an open-ended response about evolution, and that understanding evolution was inversely related to disbelief in evolution. Specifically, 32% of those who believed in evolution displayed an acceptable level of understanding in evolution, while only 14% of those who rejected evolution reached acceptable levels. Shtulman and Calabi (2008) also found that the higher participants scored on a comprehension test, the more they tended to accept evolution ($r=.50$, $p<.001$).

Lastly, Nadelson and Southerland (2010b) have suggested that the majority presence of null results is due to the use of knowledge measures that tap respondents' understanding of microevolution, but leave macroevolution largely unexamined. Briefly, microevolution is change within a species, and macroevolution covers changes between species, i.e., the evolution of a new, related species from a common ancestor. The distinction between micro- and macroevolution is artificial; they are both driven by the same underlying mechanisms (e.g., mutation, natural selection), and merely describe different “scales” (small and large), or timeframes (short and long) of evolution. Many evolution deniers accept the presence of microevolution, but deny the possibility of macroevolution (Scott, 2004). After constructing an index of knowledge of macroevolution (Nadelson & Southerland, 2010a) Nadelson & Southerland (2010b) found that knowledge of macroevolution predicts belief ($r=.35$, $p<.01$), and that the number of previous biology courses also correlated significantly with belief ($r=.27$, $p<.01$).

What could account for the typical lack of relationship between knowledge of evolution and belief in evolution? It seems that, first, a basement (or “floor”) effect of knowledge may be diluting the relationship. Second, the measures used to capture knowledge of evolution could be flawed and insensitive. Even in the most advanced population of learners and respondents (college students), knowledge is low (Nehm & Reilly, 2007). If biology majors retain misconceptions and religious preconceptions about the history of life even after a college-level biology course and intensive units on evolution (e.g., Chinsamy & Plagányi, 2007), lay understanding of evolution is likely poorer. Indeed, only 55% of Americans can correctly associate Darwin with any of his major ideas (e.g., evolution, natural selection; Newport, 2009). Moreover, a mere 35% of Americans seem to think that evolution is well supported by evidence, despite that a full 82% of Americans claim to be very informed (45%) or somewhat informed (37%) about evolution (Plutzer & Berkamn, 2008). With few respondents in any population actually reaching acceptable levels of understanding, and many relying on misconceptions to explain evolution, perhaps participants do not have some minimal level of understanding that must be reached before evolutionary theory becomes undeniably compelling. That is, knowledge of evolution among average participants may be too low for them to use evolutionary theory as a cogent and complete explanatory framework, and therefore, for their knowledge of evolution to impact other beliefs. This restricted range of knowledge, constantly at low levels, may preclude researchers from finding a relationship between knowledge and acceptance.

Problems may also exist with the available methods of knowledge measurement. First, most of the open-ended measures found no relationship with belief (e.g., Bishop & Anderson, 1990), which could be attributed to the difference between recognition and recall. This is analogous to the process of political candidate evaluation proposed by Lodge, McGraw, and Stroh (1989), wherein individuals do not construct evaluations of a candidate from a veridical or even representative search of relevant information stored in their long-term memory. Instead, evaluations are formed “online,” retrieving from memory a simple impression of the candidate, dredging up traces of the original memory only when pressed, and on the whole forgetting the actual pieces of evidence that led to their original impression. The situation with beliefs about evolution may operate in an identical fashion: belief in evolution or creationism may be based on a large body of encoded information, and free recall response methods only tap into a small subset of this larger body of knowledge. This would make open-ended responses unrepresentative of the information that has formed the respondents’ beliefs and opinions about evolution.

A further set of problems may come from the repeated use of potentially unreliable measures. The most popular method for capturing closed-response knowledge of evolution has been the Conceptual Inventory of Natural Selection (CINS; Anderson, Fisher, & Norman, 2002). Unfortunately, the point biserial values for six of the twenty items in the CINS are actually below the desirable minimum of .30, and only six others reach a value of .40. Additionally, as Nadelson and Southerland (2010b) point out, the CINS focuses primarily on microevolution; while Nadelson and Sinatra (2010) found the CINS to be unrelated to acceptance of evolution, Nadelson and Southerland (2010b) found that knowledge of macroevolution did predict acceptance. Therefore, the present study will use the best loading items from the CINS (Anderson et al., 2002) and Nadelson and Southerland's Measure of Understanding of Macroevolution (MUM; 2010a) to create a reliable composite measuring both micro- and macroevolution, wherein any effect of knowledge on acceptance of evolution should surface.

Hypothesis 1. *Knowledge of evolution will have a positive main effect on acceptance of evolution*.

Religiosity

Religiosity is perhaps the most often cited reason for low rates of acceptance of evolution (e.g., Blackwell, Powell, & Dukes, 2003). Indeed, it seems relatively straightforward that, because of the religious motivations underlying creationism (e.g., Miller, Scott, & Okamoto, 2006), religiosity should be a corollary of views towards teaching evolution. According to Scott (2004), "Religious objections to evolution are far more important in motivating anti-evolutionism than are scientific objections to evolution as a weak or unsupported theory" (p. xxiii). Indeed, in a 2007 Gallup poll (Newport, 2007), of those who did not believe in evolution 72% cited religious reasons, while only 14% cited a perceived lack of evidence.

Corollaries of religiosity, such as church attendance (e.g., Rohrbaugh and Jessor, 1975), show strong effects on acceptance of evolution. In a 2009 Gallup poll (Newport, 2009) only 25% of those who attended church weekly believed in evolution, compared to 55% of those who seldom or never attend church. Church attendance did not vary greatly according to education, suggesting that these differences "reflect a direct influence of religious beliefs on belief in evolution" (p. 3). A 2009 Pew Research Center (hereafter "Pew"; Leshner, 2009) poll found that 51% of people who seldom or never attended church believed in evolution; this number jumped to 60% of those who did not affiliate with any particular religious denomination, and fell as low as 9% for white evangelicals.

Gallup polls typically find that about 25% to 15% of respondents believe in biological evolution, whereas Pew polls typically find higher rates, around 25% to 30% (Plutzer & Berkman, 2008; Keeter, Masci, & Smith, 2007). A Pew report (Kohut, 2005) suggests these differences are caused by presentation and wording differences between Gallup and Pew. Specifically, Pew makes reference to life having "evolved due to natural processes such as natural selection," whereas Gallup asks if "Human beings have developed over millions of years from less advanced forms of life, but *God had no part in this process*" (emphasis added). It is quite likely that for many respondents, "agreeing with this last statement could imply a denial of belief in God" (a further indication of the effect of religiosity on acceptance of evolution; p. 1). Note that the Pew method, which finds about 10% greater acceptance, does not make reference to any supernatural being or process, thus indicating a latent influence of religiosity.

A small handful of empirical studies have borne out the relationship between religiosity and acceptance of evolution, and results are not nearly as mixed as those looking for knowledge effects. Typically, religiosity and acceptance of evolution correlate around -.42 to -.45 (Lombrozo, Thanukos, & Weisberg, 2008), and on one occasion, at -.60 (Nadelson & Sinatra, 2010). In a multinational sample, Miller et al. (2006) created a structural equation path model and found a path coefficient of -.42 for the influence of religiosity on acceptance of evolution. This coefficient was nearly twice as high as the European sample's coefficient of -.24.

Hypothesis 2. *Religiosity will have a negative main effect on acceptance of evolution*.

No study thus far has examined any potential interaction between knowledge of evolution and religiosity in predicting acceptance of evolution. It is clear, however, that many people reject evolution for religious reasons. Remember that of those who did not believe in evolution 72% cited religious reasons (Newport, 2007; it seems reasonable to assume that many of the 14% citing a lack of evidence have religious motivations as well). Masci (2009) noted a *Time* magazine poll, wherein respondents were asked if they would accept scientific findings if the findings disproved a religious belief; 64% of respondents said they would continue to hold to the religious belief and reject the scientific findings. It seems therefore that the presence of religiosity somewhat precludes a possible influence of increased knowledge. That is, an effect of knowledge of evolution should be stronger for individuals who are lower in religiosity where there are fewer barriers to acceptance.

Hypothesis 3. *Religiosity will moderate the effect of knowledge on acceptance of evolution, such that participants low in religiosity will be more accepting if they are high in knowledge of evolution and less accepting if they are low in knowledge; those high in religiosity will be less accepting, regardless of knowledge.*

Although the effect of religiosity on acceptance of evolution is robust in previous research, nowhere have the effects of religiosity and knowledge been separated or controlled for in a multivariate analysis with acceptance of evolution as a dependent variable. That is, no study seeking to uncover an effect of knowledge of evolution on acceptance has, thus far, attempted to control for the well-known effect of religiosity on acceptance. Because of this robust effect of religiosity on acceptance of evolution, one specific empirical question presents itself as needing clarification: Does knowledge of evolution predict acceptance above and beyond the effect of religiosity? Religiosity's effect on acceptance of evolution may be confounding the effect of knowledge of evolution on acceptance; the effect of knowledge should become clearer when the confounding effect of religiosity is removed.

Hypothesis 4. *Knowledge of evolution will have a significant effect on acceptance of evolution above and beyond the effect of religiosity.*

Support for evolution education has also been shown to vary with political ideology (Newport, 2008), where the biggest discrepancies in levels of support are typically found. A Gallup report (Carlson, 2005) found that a full 45% of conservatives would be upset if only evolution was taught (but only 4% would be upset if only creationism was taught), whereas 20% of liberals would be upset if evolution was taught (and 34% would be upset if only creationism was). However, because political ideology is strongly related to religiosity (e.g., Altemeyer & Hunsberger, 1992), and antievolution sentiments typically have religious motivations (e.g., Scott, 2004) it is reasonable to expect that the effect of ideology will be significantly reduced once religiosity is controlled for. Indeed, Keeter and Masci (2007) conclude that "deeper analysis shows that religious factors are far more important than political ones in explaining beliefs about evolution."

Hypothesis 5. *Political ideology will not account for a significant amount of the variance in acceptance of evolution above and beyond the effect of religiosity.*

Part Two: Teaching Evolution

Concomitant with the lay public's division over the truth of evolutionary theory has been a persistent effort on part of creationists to include creationism, and its twin, Intelligent Design, and exclude evolution from science classrooms (Superfine, 2009; Antolin & Herbers, 2001; Carlson, 2005; Berkman & Plutzer, 2011; Plutzer & Berkman, 2008; Berkman, Pacheco, & Plutzer, 2008; Branch & Scott, 2009; Scott, 2006, 2004; Leshner, 2005).

Public Schools

Under the Establishment Clause of the First Amendment, teaching creationism (e.g., in *Edwards c. Aguillard*, 1987) or Intelligent Design (*Kizmiller v. Dover Area School District*, 2005) is a violation of the United States Constitution (see Superfine, 2009; Scott, 2004). Yet, there exists huge support for teaching nonscientific "alternatives" to evolution among many lay individuals (nonscientists); even more individuals express interest in teaching these "alternatives" than disbelieve in evolution. A 2005 Gallup poll (Carlson, 2005) found that only 22% of people would be upset if creationism was taught in public schools (76% would not be upset). In fact, more (34%) reported that they *would* be upset if evolution was taught, and fewer (63%) *would not* be upset if evolution was taught. It is somewhat unclear just what deeper content lies behind people's position on this issue, and polls have not probed into what respondents are thinking when they advocate for one approach or another (Leshner, 2005). Therefore, the present study will be clear in conveying that supporting creationism or evolution means that the respondent considers it to be a valid scientific explanation for the history of life on earth, therefore meriting inclusion in science class.

A majority of republicans (Newport, 2007) and those higher in religiosity (e.g., Newport, 2009; Keeter & Masci, 2007) doubt the validity of evolution. These two characteristics (republican, religious) also predict support for teaching creationism in schools, and a lack of support for teaching evolution (Carlson, 2005). Taken together, this suggests the obvious conclusion that one's beliefs about evolution will predict one's stance on what should be taught in science class. Unfortunately, little data or studies exist to further inform *Hypothesis 6* in elucidating what might predict a desire for evolution or creationism to be taught in public schools. Nevertheless, with religiosity being closely associated to personal beliefs regarding the validity of evolution, the present study anticipates that this relationship will in turn influence beliefs about evolution education.

In short, it seems reasonable and parsimonious to assume that one's own acceptance of evolution should be the primary predictor of support for evolution and/or creationism education.

Hypothesis 6. *Acceptance of evolution will positively predict support for teaching evolution, and negatively predict support for teaching creationism and support for teaching both evolution and creationism side-by-side, in public schools.*

Carlson (2005) found that 45% of respondents would not be upset if either creationism or evolution was taught in public schools, while 30% would be upset if evolution was taught and creationism was not, and 18% would be upset if creationism, but not evolution, was taught. These positions map well onto the finding that creationists are more confident in their positions than those who accept evolution (Plutzer & Berkman, 2008). In other words, it would seem that the confidence that creationists have in their positions, and the lack of confidence that those who accept evolution have, could be responsible for the finding that more people would be upset if evolution was taught than if creationism was taught. However, most Americans are not very confident about origin-of-life explanations, with a full 75% of respondents having no definite opinion about either evolution or creationism (Moore, 2005). Regardless, it seems reasonable here to predict that the more confident one is in their own position, the stronger would be their advocacy that their position is taught in science class. Although little data exists to further inform *Hypothesis 7*, it is especially important as a research question regarding the public controversy over evolution. Specifically, because creationists are more confident in their position than those who accept evolution, this creates an imbalance in support for evolution or creationism education *in the wrong direction*—if confidence moderates the relationship as hypothesized.

Hypothesis 7. *The effect of acceptance of evolution on support for teaching evolution, creationism, or both evolution and creationism side-by-side will be moderated by confidence in one's own position.*

Tolerance: Political and Scientific

According to Scott (2004), fairness reflects an American cultural value, and leads people to desire equal time for hearing both sides, with input from all interested party members. For the present study, this desire to give a fair hearing to both or all sides of an issue will be conceptualized as a desire to *tolerate* alternative positions. Tolerance has a long history in political psychology and political science (e.g., Stouffer, 1955; Sullivan, Pierson, & Marcus, 1982), where it is studied as *political tolerance*—the willingness to extend basic civil liberties to disliked groups, such as communists or the KKK. Prothro & Grigg (1960) found widespread support for the general democratic value of tolerance, although this support disappeared when applied to specific controversial issues. In other words, people generally support tolerance, but this support is not necessarily manifest in their responses to specific situations. For example, people often give *intolerant* responses to disliked groups when asked to tolerate specific behaviors, such as a communist making a speech in one's community.

Analogously, the desire for tolerance within the domain of science and science education cuts across many diverse religious orientations, and is perhaps therefore an even more powerful force behind antievolutionism than fundamentalist religiosity itself

(Scott, 2004, p. xxiv), although it too may disappear in specific applications. For the present study, this will be called *science tolerance*, that is, the desire to tolerate the expression of science-related ideas with which one disagrees. This domain of tolerance has yet to be studied empirically. It is expected that those lower in science tolerance will be less accepting of origin beliefs different from their own.

Hypothesis 8*: Science tolerance will moderate the relationship between acceptance of evolution and support for teaching evolution, creationism, and both side-by-side.*

Part Three: Arguing for Evolution Education

Religiosity is negatively related to acceptance of evolution (Newport, 2009), and about two-thirds of Americans say that they would reject new scientific findings if they contradicted a religious belief (e.g., Masci, 2009; Newport, 2007). The present study aims to see whether or not a persuasive, evidence-based, pro-evolution education message can positively influence attitudes towards the "evolution v. creationism controversy," and how one's acceptance of evolution plays into receptiveness towards this pro-evolution message. To do so, the present study will include a maximally persuasive message advocating the teaching of evolution and the exclusion of creationism in public school science classes, as per the national guidelines (National Academy of Science, 1998).

Hypothesis 9a. *Exposure to an evidence-based pro-evolution communication will positively influence all participants in the pro-teaching evolution direction.*

If those who originally did not accept evolution are persuaded by the pro-evolution argument, an interaction between argument condition and acceptance of evolution should emerge, such that acceptors of evolution are not persuaded (because they already accept evolution), whereas deniers are persuaded.

Hypothesis 9b. *Exposure to an evidence-based pro-evolution communication will positively influence participants in a pro-teaching evolution direction, but this effect will primarily emerge for those originally less accepting of evolution*.

CHAPTER TWO

METHODS AND MATERIALS

Participants and Sampling

For the present study I used a convenience sample of undergraduate psychology students. Students enrolled in an introductory psychology course volunteered to participate in the study in return for one credit toward their course's research participation requirement. This sampling method has the advantage of affording a large potential sample size at relatively no cost. The subject pool is typically homogenous in terms of age and years of education, which is advantageous for the purposes of this study as education is thereby held nearly constant.

A total of 196 Loyola Undergraduates enrolled in an introductory psychology course were recruited to participate in the experiment. The sample consisted of 40 men and 152 women (4 did not respond). Participants ranged in age from 18 to 50 years old (M=18.89).

Procedure

Upon enrolling, participants were given access to a URL where they could complete the online experiment. Participants were then asked for their consent to participate and informed that they would be answering questions about science and science education. The survey instructions would differ depending on the condition to which the participant was randomly assigned (experiment or control).

Participants in the pro-evolution argument condition were informed that the researchers are interested in their opinions regarding issues in science education policy. After a brief description of the "evolution vs. creationism controversy" as the given science education issue, participants were told that in order to inform them more and help them make a decision about the policy, they will read a randomly selected statement that is either in favor or opposed to teaching creationism in science class. Participants in the control condition read about an issue in science education unrelated to evolution.

Upon reading the condition-specific instructions and materials, all participants were asked to report their attitudes towards different approaches to teaching about the history of life in science class, as well as their own personal views on the history of life on earth (see below). Participants were then asked to respond to a twenty-item measure of knowledge of evolution, (see below). After completing the knowledge measure, participants were asked to pick, from a list, a science-related idea with which they disagreed, and asked several questions about their tolerance of the chosen disagreeable idea. After the tolerance questionnaire, participants were asked to report their responses to various political and demographic items (see below).

Materials

Stimulus Materials

Participants in the pro-evolution argument condition all read the same statement from the same source. The given source characteristics was as follows: Ken Miller, PhD; age 56; Biology Professor at a local public university; Teaches Biology 101 and Biology 105. Participants in the pro-evolution argument condition read an argument attributed to

Dr. Miller as his response to the controversy, which argues in favor of teaching evolution, and not creationism, in science class. The communication was evidence-based and drew on previous legal precedent for this position, as well as support from the nature of science, as it relates to the controversy.

Measures

Participants were asked three questions to assess their support for teaching evolution, creationism, or both, for a total of 9 questions (e.g., When it comes to teaching about the history of life, I think that public school science classes should teach only the scientific theory of evolution.). Participants reported their agreement on a scale from 1 (disagree strongly) to 7 (agree strongly) (see Appendix).

Participants completed Rutledge and Warden's (1999) Measure of the Acceptance of the Theory of Evolution (MATE). This is a 20 item measure of five-point scale items (e.g., "Evolution is not a scientifically valid theory") ranging from 1 (strongly disagree) to 5 (strongly agree); (see Appendix).

Participants were asked to report their origin beliefs (e.g., creationism) in a similar fashion to the methods utilized by the Pew Research Center (people-press.org, 9/28/2005), which classifies participants as believing in either "creationism," "theistic evolution," or "biological evolution," based on their responses to the following statement: “Some people think that humans and other living things have evolved over time. Others think that humans and other living things have existed in their present form since the beginning of time. Which of these comes closest to your view?”

1. All life, including humans, evolved over millions of years through completely natural processes such as natural selection.
2. All life, including humans, evolved over millions of years, but this process was guided by a supreme being.
3. All life, including humans, was created by a supreme being pretty much in its present form at one time within the last 10,000 years or so.

The first option reflects an acceptance of biological evolution, the second reflects theistic evolution, and the third reflects a creationist. After selecting one of the three options, participants were presented with their selection and asked to report their confidence in this position (e.g., I am confident that this is actually true) on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree); (see Appendix).

Participants completed items from the CINS (Anderson et al., 2002) and Nadelson and Southerland's Measure of Understanding of Macroevolution (MUM; 2010a) to create a composite measure of knowledge that taps into both micro- and macroevolution. This was a 20-item, multiple choice test of basic knowledge of evolution, designed to address main themes of micro- and macro-evolution, such as limited resources, genetic variation, and differential survival (see Appendix).

Religiosity was measured with four questions that reliably correlate with overall religiosity (e.g., "How religious would you say you are?"; Rohrbaugh and Jessor, 1975). Items used a ten-point scale from one (never/not at all) to ten (very much); (see Appendix).

Participants were asked to report their political ideology on a seven-point scale ranging from 1 (extremely conservative) to 7 (extremely liberal) with a midpoint of "moderate". Participants also were asked to report their party identification on an ordinal scale with the following options: Strong Democrat, Moderate Democrat, Independent, Moderate Republican, Strong Republican.

Participants were told that the researchers were interested in their opinions regarding “the expression of ideas in science,” and were presented with a list of statements of “controversial” ideas in science (e.g., “Climate change is NOT occurring,” see Appendix for full list). After reading the list, they were asked, “Which ONE of the following statements do you DISAGREE with MOST?” After selecting the most disagreeable statement, they will respond to ten statements regarding specific situations where tolerance or intolerance of the disagreeable statement is elicited (e.g., “People who believe that [e.g., Climate change is NOT occurring] should be allowed to use public college campuses to hand out pamphlets expressing their views”). Participants then reported their agreement on a scale from 1 (disagree strongly) to 7 (agree strongly) (see Appendix). This scale was piloted and pre-tested, and demonstrated desirable reliability (α=.87).

CHAPTER THREE

RESULTS

Statistical Treatment Overview

Except when otherwise noted, multiple regression was used to analyze the data for the present study (e.g. Hypothesis 9a was analyzed with a MANOVA). Continuous moderating variables (e.g., science tolerance, confidence) were centered (by subtracting participant's scores on each scale from the sample mean). All two-way interaction terms (between, e.g., confidence and condition) were created by multiplying the appropriate variables together. These terms were entered into a multi-step hierarchical regression (i.e., all main effects entered at Step 1, all main effects and two-way interactions at Step 2). By using this statistical approach, omnibus main effects can be tested at Step 1 and omnibus two-way interactions can be tested at Step 2, and so on for any higher-order interactions (Cohen & Cohen, 1983). When significant interactions were found between predictors and/or condition and the predicted moderators, simple effects were explored via regression with interaction using the techniques outlined by Aiken and West (1991).

Preliminary Analyses

Reliability Analyses

Composite scores were created for all multi-item measures, including acceptance of evolution, knowledge of evolution, religiosity, confidence in beliefs about evolution, science tolerance, and support for teaching evolution, creationism, or both. Reliability analyses were performed to determine how best to create these composite scores.

All ten science tolerance items were internally reliable upon initial analysis (α=.840), and so all twenty items were included in participants' composite science tolerance score. Acceptance of evolution was also internally reliable (α=.941) as was confidence in origin beliefs (α=.833), religiosity (α=.925), and knowledge of evolution (α=.811). All items were retained for participants' composite scores on these indices.

Acceptance, Belief, and Evolution Education Descriptives

Participants were overall more accepting of evolution than not, with average MATE scores of 3.87 out of 5 (*SD*=.671, *n*=196). In response to the origin belief question modeled after the Pew Research Center's, participants were also generally accepting of evolution, with few participants choosing the strictly creationist viewpoint; for comparison to a national sample, percentages taken from Leshner (2005) are included in the right-hand column (See TABLE 1). Participants were also highly supportive of teaching evolution (*M*=3.40, *SD*=.975, *n*=196) and of teaching both evolution and creationism (*M*=3.74, *SD*=1.154, *n*=196), and very low in support of teaching only creationism (*M*=2.07, *SD*=.912, *n*=196).

Table 1: Origin Belief

	Frequency	Percent	Leshner ('05)
(1) All life, including humans, evolved over millions of years through completely natural processes such as natural selection	87	44.4%	26%
(2) All life, including humans, evolved over millions of years, but this process was guided by a supreme being.	91	46.4%	18%

(3) All life, including humans, was created by a supreme being pretty much in its present form at one time within the last 10,000 years or so.	18	9.2%	42%

Bivariate Relations Between Variables

Preliminary analyses were performed to examine the relation between condition and the continuous predictor variables of knowledge of evolution and acceptance of evolution. Two between-groups t-tests were performed to determine whether or not participants in the experimental condition differed significantly in their scores on these variables from participants in the control condition. Results indicated that there were no significant differences between participants in the experimental and control conditions on these two variables (all $p>.05$). Thus, random assignment to the three conditions successfully avoided confounds with the measured predictor variables.

Additional preliminary analyses examined the relation between the continuous predictor variables and the demographic variables. All predictors did not differ significantly according to gender (all $p>.05$), with the exception of religiosity, where men ($M = 4.294$) scored significantly lower than women ($M = 5.281$), $t\ (190) = -2.145$, $p = .033$. Age did not correlate significantly with any of the predictor variables (all $p > .05$).

Main Analyses

Three sets of analyses were performed. First, the effects of knowledge of evolution and religiosity on acceptance of evolution were tested. Second, the effect of acceptance of evolution and potential moderating effects of science tolerance and confidence in origin beliefs on support for teaching evolution, creationism, or both, were tested. Lastly, the effects of condition on support for teaching evolution, creationism, or both, were tested.

Predicting Acceptance of Evolution

Did knowledge of evolution have a positive main effect on acceptance of evolution, and did religiosity have a negative main effect on acceptance of evolution? As expected, a regression revealed that participants higher in knowledge of evolution were more accepting of evolution compared with participants lower in knowledge of evolution, $B = .069$, $\beta = .449$, $t\ (192) = 6.952$, $p < .001$. Also as expected, participants higher in religiosity were less accepting of evolution compared to participants lower in religiosity, $B = -.093$, $\beta = -.362$, $t\ (191) = -5.352$, $p < .001$.

Did religiosity moderate the effect of knowledge of evolution on acceptance of evolution? To test this hypothesis, an interaction term between religiosity and knowledge of evolution was created by first centering each variable and then multiplying the centered terms together. In line with Aiken & West (1991), main effects were entered at Step 1, and the interaction term was entered at Step 2, of a hierarchical regression. The regression revealed a significant combined main effect of religiosity and knowledge of evolution at Step 1, $R^2 = .332$, $F\ (2, 189) = 46.872$, $p < .001$. Step 2, however, revealed no significant increase in R^2, $\Delta R^2 = .001$, $\Delta F\ (1, 190) = .293$, $p = .589$. This suggests that there is no interaction between knowledge of evolution and religiosity. In other words, it does not seem that the effect of knowledge of evolution on acceptance of evolution depended on participants' religiosity.

Did knowledge of evolution have a significant effect on acceptance of evolution above and beyond the effect of religiosity? To answer this question, religiosity was entered at Step 1, and knowledge of evolution at Step 2, of a hierarchical regression, with acceptance of evolution as the dependent variable. Step 1 revealed, as known in above analyses, that religiosity significantly predicts acceptance of evolution, $R^2 = .131$, F (1, 190) = 28.642, $p < .001$. Step 2 revealed a significant change in the R^2, $\Delta R^2 = .201$, ΔF (1, 189) = 56.705, $p < .001$, suggesting that knowledge of evolution significantly predicts acceptance of evolution above and beyond the effect of religiosity.

When controlling for religiosity, is the effect of political ideology no longer significant? It should be noted here that political ideology did significantly predicted acceptance of evolution, $B = .147$, $\beta = .295$, t (189) = 4.238, $p < .001$, such that liberal participants were more accepting of evolution compared to conservative participants. Party affiliation showed a similar effect on acceptance of evolution, $B = -.088$, $\beta = -.194$, t (188) = -2.706, $p = .007$, with more democratic participants showing higher levels of acceptance.

To answer the above question, religiosity was entered at Step 1, and both religiosity and political ideology at Step 2, of a hierarchical regression, with acceptance of evolution as the dependent variable. As known from above analyses, Step 1 again revealed that religiosity significantly predicts acceptance of evolution, $R^2 = .130$, F (1, 189) = 28.208, $p < .001$. Contrary to predictions, Step 2 revealed a significant change in the R^2, $\Delta R^2 = .045$, ΔF (2, 188) = 10.215, $p = .002$. The same analysis was performed with political party affiliation in place of political ideology, and Step 2 again revealed a significant change in R^2, ΔR^2 = .022, ΔF (2, 187) = 4.907, p = .028. This suggests that political ideology and party affiliation both significantly predict acceptance of evolution above and beyond the effect of religiosity. That is, political ideology and party affiliation represent unique factors that contributed to participants' acceptance of evolution.

With political ideology and party affiliation included in the model with knowledge of evolution and religiosity, the overall R^2 is 369. However, in this model, the effect of party affiliation is no longer significant, B = -.015, β = -.032, t (185) = -0.463, p = .644. With party affiliation excluded from the model, the overall R^2 is 368, and all predictors are significant at the p < .001 level. It seems, therefore, that political beliefs are important in predicting acceptance of evolution, and that the effect of political ideology overshadows that of party affiliation.

Predicting Support for Teaching Evolution, Creationism, or Both

Did acceptance of evolution positively predict support for teaching evolution, and negatively predict support for teaching creationism and support for teaching both evolution and creationism side-by-side, in public schools? To test this hypothesis, three regressions were performed using acceptance of evolution as a predictor, and one of each with support for teaching evolution, creationism, and both, as dependent variables, respectively. The first regression showed that acceptance of evolution significantly predicts support for teaching evolution, B = .828, β = .570, t (194) = 9.664, p < .001, with participants who are more accepting of evolution showing greater support for teaching evolution compared to participants low in acceptance of evolution. The second regression showed that acceptance of evolution significantly predicted support for teaching creationism, $B = -.813$, $\beta = -.598$, t (194) = -10.404, $p < .001$, with participants higher in acceptance of evolution showing less support for teaching creationism than participants lower in acceptance of evolution. Lastly, the third regression showed that acceptance of evolution also significantly predicted support for teaching both evolution and creationism, $B = -.733$, $\beta = -.426$, t (194) = -6.566, $p < .001$, with participants higher in acceptance of evolution showing less support for teaching both evolution and creationism compared to participants less accepting of evolution.

Was the effect of acceptance of evolution on support for teaching evolution, creationism, or both evolution and creationism side-by-side moderated by confidence in one's own position? To test this hypothesis, an interaction term was created by centering acceptance of evolution and confidence and multiplying the centered predictors. Then, three hierarchical regressions were performed, with acceptance of evolution and confidence entered at Step 1, and the interaction term included at Step 2, with support for teaching evolution, creationism, and both, entered as dependent variables, respectively.

The first hierarchical regression showed that acceptance of evolution and confidence significantly predict support for teaching evolution, at Step 1, $R^2 = .327$, F (2,193) = 46.952, $p < .001$. Contrary to predictions, Step 2 revealed no significant change in the R^2, $\Delta R^2 = .004$, ΔF (1, 192) = 1.263, $p = .262$.This suggests that the effect of acceptance of evolution on support for teaching evolution did not depend on participants' degree confidence in their beliefs about the origin of life.

The second hierarchical regression showed that acceptance of evolution and confidence significantly predict support for teaching creationism, at Step 1, $R^2 = .358$, F

(2,193) = 53.875, $p < .001$. Contrary to predictions, Step 2 revealed no significant change in the R^2, $\Delta R^2 = .001$, ΔF (1, 192) = .173, $p = .678$.This suggests that the effect of acceptance of evolution on support for teaching creationism did not depend on participants' degree confidence in their beliefs about the origin of life.

The third hierarchical regression showed that acceptance of evolution and confidence significantly predict support for teaching both evolution and creationism, at Step 1, $R^2 = .192$, F (2,193) = 22.934, $p < .001$. Consistent with predictions, Step 2 revealed a significant change in the R^2, $\Delta R^2 = .025$, ΔF (1, 192) = 6.115, $p = .014$.This suggests that the effect of acceptance of evolution on support for teaching both evolution and creationism depended on participants' degree confidence in their beliefs about the origin of life.

To probe this interaction, follow up regressions were performed by computing variables for participants high, and low, in confidence (one standard deviation above or below; Aiken & West, 1991) and inserting them in the original model in place of confidence. This analysis revealed a significant effect of acceptance of evolution for participants high in confidence in their origin beliefs in predicting support for teaching both evolution and creationism, $B = -.861$, $\beta = -.501$, t (192) = -6.475, $p < .001$, but no significant effect of acceptance for participants low in confidence, $B = -.312$, $\beta = -.182$, t (192) = -1.647, $p = .101$ (See Figure 1).

Figure 1: Acceptance X Confidence

A post-hoc follow-up confirmatory analyses (ANOVA) showed that participants did not differ in confidence according to their origin beliefs, $F(2, 193) = .060$, p = ns. Of those who believed live evolved according to natural forces, the average level of confidence was 5.64 (n=87, SD=1.128); of those who thought life evolved but with guidance from a supreme being, 5.59 (n=91, SD=1.043); and among creationists, 5.56 (n=18, SD=1.294).

Did science tolerance—the tolerance of the expression of science-related ideas with which one disagrees—moderate the relationship between acceptance of evolution and support for teaching evolution, creationism, and both? To test this hypothesis, an interaction term was created by centering science tolerance and acceptance of evolution and multiplying the centered predictors. Then, three hierarchical regressions were performed, with acceptance of evolution and science tolerance entered at Step 1, and the interaction term included at Step 2, with support for teaching evolution, creationism, and both, entered as dependent variables, respectively.

The first hierarchical regression showed that acceptance of evolution and science tolerance significantly predict support for teaching evolution, at Step 1, R^2 = .347, F (2,190) = 50.475, p < .001. Contrary to predictions, Step 2 revealed no significant change in the R^2, ΔR^2 = .006, ΔF (1, 189) = 1.689, p = .195.This suggests that the effect of acceptance of evolution on support for teaching evolution did not depend on participants' degree of science tolerance.

The second hierarchical regression showed that acceptance of evolution and science tolerance significantly predict support for teaching creationism, at Step 1, R^2 = .365, F (2,190) = 54.712, p < .001. Contrary to predictions, Step 2 revealed no significant change in the R^2, ΔR^2 = .005, ΔF (1, 189) = 1.630, p = .203.This suggests that the effect of acceptance of evolution on support for teaching creationism did not depend on participants' degree of science tolerance.

The third hierarchical regression showed that acceptance of evolution and science tolerance significantly predict support for teaching both evolution and creationism, at Step 1, R^2 = .192, F (2,190) = 22.565, p < .001. Contrary to predictions, Step 2 revealed no significant change in the R^2, ΔR^2 = .002, ΔF (1, 189) = .567, p = .452.This suggests that the effect of acceptance of evolution on support for teaching both evolution and creationism did not depend on participants' degree of science tolerance.

Regression analyses showed that science tolerance did have a main effect on the support for teaching evolution, creationism, or both. Participants higher in science tolerance were less supportive of teaching just evolution, B = -.220, β = -.254, t (192) = --3.628, p < .001. However, participants high in science tolerance were more supportive of teaching creationism, *B* = .1221, *β* = -.151, *t* (192) = 2.116, *p*=< .036, and of teaching both, *B* = .196, *β* = .192, *t* (192) = 2.702, *p* = .008.

Condition by Support for Teaching Evolution, Creationism, or Both

Did exposure to the evidence-based pro-evolution communication positively influence participants in the pro-teaching evolution direction and away from support for teaching creationism, or both? To test this hypothesis, a one-way between-subjects multivariate analysis of variance was performed on three dependent variables: support for teaching evolution, support for teaching creationism, and support for teaching both. One independent variable—condition—was used (experimental and control). The one-way MANOVA revealed a significant multivariate main effect for condition, *Wilks' λ* = .955, *F*(3, 192.00) = 3.008, *p* = .031, *partial eta squared* = .045, and power to detect the effect was .703.

Given the significance of the overall test, the univariate main effects were examined. A significant univariate main effect of condition was obtained for support for both evolution and creationism, *F* (1,194) = 9.062, *p* = .003, partial eta square =.045, power = .850. A marginally significant effect of condition was obtained for support for teaching evolution, *F* (1,194) = 3.002, *p* = .085, partial eta square =.015, power = .407. Lastly, the effect of condition on support for teaching creationism was not significant, *F* (1,194) = .974, *p* = .325, partial eta square =.005, power = .166.

Was the effect of condition on support for teaching evolution, creationism, or both, moderated by participants' acceptance of evolution? That is, did the effect primarily emerge for those originally less accepting of evolution? To test this hypothesis, an interaction term was created by centering acceptance of evolution and multiplying the centered predictor with condition. Then, three hierarchical regressions were performed, with acceptance of evolution and condition entered at Step 1, and the interaction term included at Step 2, with support for teaching evolution, creationism, and both, entered as dependent variables, respectively.

The first hierarchical regression showed that acceptance of evolution and condition significantly predict support for teaching evolution, at Step 1, $R^2 = .328$, $F(2,193) = 47.147$, $p < .001$. Contrary to predictions, Step 2 revealed no significant change in the R^2, $\Delta R^2 = .001$, $\Delta F(1, 192) = .395$, $p = .530$. This suggests that the effect of acceptance of evolution on support for teaching evolution did not depend on condition.

The second hierarchical regression showed that acceptance of evolution and condition tolerance significantly predict support for teaching creationism, at Step 1, $R^2 = .358$, $F(2,193) = 53.842$ $p < .001$. Contrary to predictions, Step 2 revealed no significant change in the R^2, $\Delta R^2 = .000$, $\Delta F(1, 192) = .016$, $p = .899$. This suggests that the effect of acceptance of evolution on support for teaching evolution did not depend on condition.

The third hierarchical regression showed that acceptance of evolution and condition significantly predict support for teaching both evolution and creationism, at Step 1, $R^2 = .328$, $F(2,193) = 47.147$, $p < .001$. Consistent with predictions, Step 2 revealed a significant change in the R^2, $\Delta R^2 = .035$, $\Delta F(1, 192) = 8.885$, $p = .003$.This suggests that the effect of acceptance of evolution on support for teaching both evolution and creationism depended on condition, that is, whether or not participants had just been exposed to the pro-evolution argument.

To probe this interaction, follow up regressions were performed by computing variables for participants high, and low, in acceptance of evolution (one standard deviation above or below; Aiken & West, 1991) and inserting them in the original model in place of acceptance of evolution. Contrary to predictions, this analysis revealed a significant effect of condition for participants high in acceptance of evolution, $B = -.827$, $\beta = -.358$, $t\ (192) = -3.949$, $p < .001$, but no significant effect of condition for participants low in acceptance, $B = .047$, $\beta = .021$, $t\ (192) = .232$, $p = .817$. (See Figure 2).

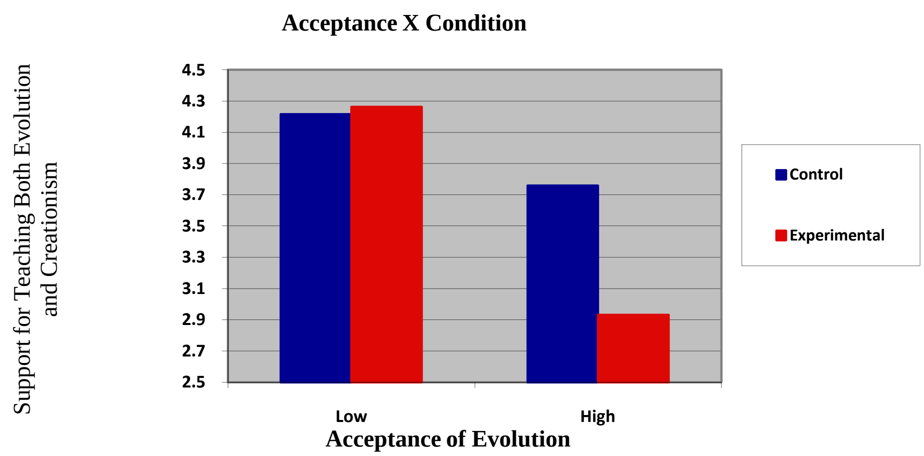


Figure 2: Acceptance X Condition

Could the Acceptance X Condition interaction effect on support for teaching both evolution and creationism be moderated by increased confidence? As a preliminary test, if confidence is causing the above interaction it should account for the variance of the interaction once entered into the mode. Therefore, acceptance of evolution, condition, and the acceptance X condition interaction were entered at step 1 of a regression, with support for teaching both evolution and creationism as the dependent variable, and confidence was added at step 2. Step 2 showed no significant improvement in the R^2, ΔR^2

= .005, ΔF (1, 191) = 1.344, p = .248, and the main effect of confidence was not significant, B = -.079, β = -.076, t (191) = -1.159, p = .248. It does not seem, therefore, that the acceptance X condition interaction is driven by confidence.

CHAPTER FOUR

DISCUSSION AND CONCLUSION

Discussion

Acceptance of Evolution

The main analyses on acceptance of evolution replicated, clarified, and progressed several findings that have been present in the evolution acceptance and education literature for the last few decades. Religiosity has consistently predicted acceptance of evolution and belief in evolution, and that robust finding was replicated in the present study. Unlike religiosity, knowledge of evolution has not consistently predicted acceptance of evolution. The present study used a composite index of the most reliable items from Anderson et al.'s CINS (2002) and Nadelson and Southerland's MUM (2010a); this composite index did predict acceptance of evolution, and did so better than any previous index of knowledge of evolution.

The present study hypothesized that religiosity would moderate the effect of knowledge of evolution on acceptance of evolution, but this hypothesis was not confirmed. Thus it seems that the effect of knowledge of evolution is equally important for all levels of religiosity. That is, knowing more about evolution seems to be important for accepting evolution for those either high or low in religiosity. Additionally, because the effect of religiosity on acceptance of evolution was so robust in previous research, and possibly masked an effect of knowledge on evolution, the present study controlled for religiosity, looking for the effect of knowledge on acceptance above-and-beyond the effect of religiosity. Analyses showed that knowledge of evolution did predict acceptance above-and-beyond religiosity, but this finding was unsurprising, since the above analyses already showed the effect of knowledge to be present and strong. In fact, in contrast to all previous research, the present study found that knowledge of evolution was the strongest overall predictor of acceptance of evolution.

Previous research found that political beliefs also predicted myriad variables related to beliefs about evolution, such as belief in evolution and support for teaching evolution. The present study hypothesized that these effects could be accounted for by the effect of religiosity, based on the correlation between religiosity and various political beliefs. These hypotheses were not confirmed. Political ideology and party affiliation showed a significant effect above-and-beyond religiosity in predicting acceptance of evolution. However, these effects were small, and the effect of party affiliation disappearing in the full model, and both political ideology and party affiliation were measured with only one indicator. Future research may further elucidate the unique effect of political ideology, and, should the effect remain, the field of evolution education may desire to account for and be mindful of people's liberalism or conservatism.

Teaching Evolution

No previous research had previously examined or confirmed the presumably straightforward relationship between acceptance of evolution and support for different evolution education policies. As hypothesized those who were more accepting of evolution were also supportive of teaching evolution, and were not supportive of teaching creationism or, importantly, of teaching both evolution and creationism. It was also hypothesized that participants' confidence in their origin beliefs would moderate this relationship. This hypothesis was partially confirmed; confidence only moderated this relationship for support for teaching both evolution and creationism. Specifically, for participants who were low in confidence in their own beliefs about evolution, their acceptance of evolution did not predict their support for teaching both evolution and creationism. But for participants highly confident in their own beliefs about evolution, those who were more accepting of evolution also showed less support for teaching both evolution and creationism.

Interestingly, the present sample was unlike previous research, in that participants did not differ in confidence according to their origin beliefs. Moreover, overall support for teaching just evolution was unusually high, and support for teaching just creationism unusually low, compared to nationally representative samples. This discrepancy may have masked a more widely moderating effect of confidence. That is, a basement effect in support for teaching just creationism, and a lack of difference across groups in confidence—neither of which are found in nationally representative samples—may have interfered with the potential moderating effect of confidence in predicting support for teaching creationism from acceptance of evolution. Future research may wish to clarify these findings. Lastly, it should be noted that science tolerance showed no moderating effects, and showed theoretically inconsistent main effects. Specifically, science tolerance was positively related to support for teaching creationism, and to teaching both evolution and creationism, but negatively to teaching just evolution. On the contrary, science tolerance should predict lower support for teaching just one option and higher support for both. Thus its main effects are not theoretically consistent with science tolerance. Further development of both the measure and the construct is needed.

Arguing for Evolution

As predicted, participants exposed to a strong, evidence-based pro-evolution argument were less supportive of teaching both evolution and creationism. However, participants exposed to the pro-evolution argument were only marginally more supportive of teaching evolution, and there was no effect on support for teaching creationism. This is likely due to the already-low overall support for teaching creationism, as well as the already-high support for teaching evolution. Moreover, the pro-evolution argument specifically argued against teaching both evolution and creationism—the current problem (support for teaching both) in the evolution education controversy—and did not specifically argue against teaching just creationism. Therefore, since the current controversy in evolution education centers around pushes to teach both creationism and evolution, this finding is still somewhat reassuring for evolution education.

Just as acceptance of evolution predicted (negatively) only support for teaching both evolution and creationism, an interaction was obtained between acceptance and condition only for predicting support for teaching both. Specifically only participants who were already accepting of evolution and in the pro-evolution argument condition showed decreased support for teaching both evolution and creationism. This finding is contrary to predictions; it was expected that participants already accepting of evolution would not need persuading, and that the arguments would be able to persuade who needed persuading—those low in acceptance of evolution.

That those low in acceptance of evolution were not persuaded recalls Sherif and Hovland's (1961) social judgement theory, and specifically, latitudes of acceptance, rejection, and noncommitment. Here, the latitude of acceptance is defined as "the range of positions on an issue that an individual considers acceptable to him (including the one "most acceptable" to him)" (p 129). Similarly, latitude of rejection comprises positions on an issue that the individual finds unacceptable, and latitude of noncommitment, the range on which the individual cannot state an opinion either way. Sherif and Hovland also note that the more extreme of a position a person takes on an issue (i.e., their "most acceptable" position), the smaller their latitude of acceptance and the greater their latitude of rejection. The pro-evolution communication argued for what could be considered an extreme stance on teaching evolution, and thus it seems likely that participants not accepting of evolution found the communication far outside of their latitude of acceptance and were thus unaffected.

It also seems that latitudes of acceptance and rejection account for the finding that those higher in acceptance of evolution were persuaded into disfavor for teaching both evolution and creationism by the pro-evolution argument. Specifically, it does not seem, for example, that their lower support for teaching both was caused by increased confidence in their own position, but simply by the argument's falling within their own latitude of acceptance, thereby being persuasive. This is consistent with the findings that religiosity is negatively related to acceptance of evolution (e.g., Newport, 2009), that instruction (teaching evolution at high school or college level) has no overall effect on belief (e.g., Lawson & Worsnop, 1992), and that two-thirds of Americans say that they would reject new scientific findings if they contradicted a religious belief (e.g., Masci, 2009).

That accepters of evolution are persuaded but deniers are not represents a significant problem for almost all pro-evolution movements, be they in science education and beyond. That is, efforts to persuade any sample of people with mixed beliefs about evolution would most likely lead only to more extreme views and a wider gap between deniers and accepters of evolution. This represents a significant problem for any person or organization with an interest in promoting evolution. It's not as if science can chose to alter the core of evolutionary theory such that falls within the latitude of acceptance of creationists. The problem, for future research, and for anybody with an interest in promoting evolution, remains one of effective outreach.

If arguing for evolution remains ineffective, more emphasis must be placed into evolution education, and more rigorous research on evolution education is needed. The present study found that higher levels of knowledge of evolution predicted greater acceptance of evolution, but the effect of learning about evolution, that is, of increasing an individual's knowledge of evolution, on their acceptance of evolution, remains to be clearly shown. Furthermore, best practice models of evolution education are also wanting; it is especially important to reach those students who are less accepting of evolution, and previous research showed these students to be least open to learning about evolution (e.g., Demastes et al., 1995; Cavallo & McCall, 2008).

Future research may also wish to explore the effect of political ideology on acceptance of evolution. Contrary to expectations, the present study did find an effect of political beliefs, especially political ideology, above and beyond the effect of religiosity. The effects were small, with the effect of party affiliation disappearing in fuller models, and both political ideology and party affiliation were measured with only one indicator. Future research is needed to elucidate the effects of political beliefs on acceptance of evolution, especially within the context of other predictors. The present effect was small and may have been due to the particular sample; fuller and more sensitive measurements and tests are needed.

Study Limitations

Limited Demographics and Religiosity

This study was limited in several way, many of which may want to be considered in future research. First, age range in this study was very limited, as is much of the literature on people's beliefs about evolution, and therefore it is not necessarily prudent to generalize these results beyond the study's limited age range. This could be especially problematic, educators and policy makers tend to be quite a bit older than college freshmen. Additionally, this study was very limited in its religious demographics, and was specifically lacking in evangelical Christian participants. This demographic (evangelical Christians) are especially active in the anti-evolution movement (e.g., Scott, 2004), and were of particular interest at the outset of the study, but too few (only two, to be precise) evangelical Christians signed up for this study, so any investigation into evangelical anti-evolution beliefs was not possible.

In addition to limited religious demographic representation, this study did not examine any effects of any particular type of religiosity (e.g., orthodoxy, church attendance, even parents' religious behavior) that could have been of particular interest. Lastly, future research should consider a particular type of believer: the "spiritual but not religious" person. This is one area of belief that seems yet to be investigated by research on beliefs about evolution, namely, how does spirituality and religiosity combine or interact and affect beliefs about evolution and evolution education?

Limited Time and Knowledge of Evolution

A more longitudinal study into beliefs about evolution would be particularly instructive on several fronts. First, while this study found an effect of knowledge of evolution on acceptance of evolution, this study was unable to examine any change over time in people's understanding of evolution. Does actually learning about evolution change beliefs? Unfortunately, it seems that no previous has actually examined this specific research question, even though some studies had the available data (pre- and post-test knowledge measures; e.g., Cavallo and McCall, 2008). Only by examining the relationship between change in knowledge with a change in acceptance of evolution can any causal relationship be drawn. For example, the effect of knowledge on acceptance found in the present study could simply be due to more accepting individuals being more interested in further learning about evolution.

It was hypothesized that the use of open-ended measures of knowledge of evolution often found no effect of knowledge on acceptance of evolution— while close-ended measures more often did—because of certain effects of recall (open-ended) vs.

recognition (close-ended), this hypothesis was not tested in the present study. Although this question may be somewhat trivial and technical, future research having to do with knowledge of evolution may wish to pursue this finding further. Additionally, while this study found, by combining reliable questions from separate metrics, a stronger effect of knowledge of evolution and acceptance of evolution than many other similar studies, this study included no further investigation into this effect. While all items from the composite measure were reliable and therefore retained, this study did not test for any further effects between the two source-measures or for any effects of types of knowledge (i.e., macroevolution vs. microevolution). That is to say, necessary and sufficient conditions for belief in evolution remain unknown. For example, Gregory (2009) summarized and visualized (in flow-chart form) Mayr's (1982) summary of the basis of natural selection, which includes five observations (e.g., populations have potential to increase exponentially; populations remain stable over time; resources are limited) and three subsequent inferences (not all offspring survive and reproduce, due to a struggle for resources), all of which are essential for a complete understanding of evolution. Is it the case that understanding all necessary observations and inferences leads to acceptance of evolution, or does general knowledge of evolution predict belief just as well?

Political Ideology

The present study featured a particularly weak look at participants' political beliefs. Political party affiliation and political ideology (liberal vs. conservative) were both captured with only one item, respectively. This limited this study's ability to examine just how and in what way participants' political ideology (but not party identification) influenced their beliefs about evolution and evolution education.

Conclusion

Future Directions

What Good is Learning About Evolution?

One of the most important questions remaining is the possible importance of learning about evolution on acceptance of evolution. As mentioned, no previous research has established this relationship, even though some had the available data (e.g., Cavallo and McCall, 2008). The method is simple: administer knowledge of evolution measures at pre- and post-test and create a difference variable (post- minus pre-test); do the same with an acceptance of evolution measure, and regress change in knowledge of evolution (and any other predictors) onto change in acceptance of evolution. This is one, if not best, way to establish the causal relationship of knowledge of evolution leading to acceptance of evolution, but the literature remains wanting.

Spiritual but not Religious

Spirituality and religiosity are empirically highly independent and have distinctly different personality correlates (Saucier & Skrzypińska, 2006), and though it may not always be clear what somebody means when they say they are "spiritual but not religious" (Marler & Hadaway, 2002), it is especially not clear how this belief affects beliefs about evolution. Future research may wish to examine how religiosity and spirituality interact in their possible effects on beliefs about evolution, or, perhaps future research may take interest specifically in those who describe themselves as "spiritual but not religious".

Argument Source and Various Communications

Future research may wish to examine how varying the source of a pro-evolution communication affects the receptivity of different sorts of participants to taking more pro-evolution stances. For example, if highly religious persons are generally receptive to advice given by their religious leaders, it may be especially useful to examine how they would react if their religious leaders took vocal, pro-evolution stances. Lastly, future research may wish to examine how people react to pro-creationism communications. After all, nearly half of Americans are creationists, and even if few people support teaching just creationism, a huge majority support the teaching of both evolution and creationism.

APPENDIX A

STIMULUS MATERIALS

We are interested in your opinion of a potential policy change regarding science education in the local school district. In order to help make a decision about the policy, please read the following statement regarding a potential change in the science curriculum. Please pay close attention to details about the speaker and the statement, you might be asked about them later in the experiment.

- Ken Miller, PhD
- Age: 56
- Biology Professor at a local public university
- Courses taught: Biology 101 and Biology 105

APPENDIX B

ATTITUDES TOWARDS TEACHING EVOLUTION AND/OR CREATIONISM

1. Regardless of what you may personally believe, when it comes to teaching about the history of life, do you agree that public schools should teach only the scientific theory of evolution?

1	2	3	4	5
Disagree strongly	Disagree	Neither agree nor disagree	Agree	Agree strongly

2. Regardless of what you may personally believe, when it comes to teaching about the history of life, do you agree that public schools should teach only creationism?

1	2	3	4	5
Disagree strongly	Disagree	Neither agree nor disagree	Agree	Agree strongly

3. Regardless of what you may personally believe, when it comes to teaching about the history of life, do you agree that public schools should teach both creationism and the scientific theory of evolution?

1	2	3	4	5
Disagree strongly	Disagree	Neither agree nor disagree	Agree	Agree strongly

4. If the public schools in your community taught the theory of evolution—that is, the idea that human beings evolved from other species of animals—how upset would you be?

1 2 3 4 5
Not at all upset Somewhat upset Very upset

5. If the public schools in your community taught the theory of creationism—that is, the idea that human beings were created by God in their present form and did not evolve from other species of animals—how upset would you be?

1 2 3 4 5
Not at all upset Somewhat upset Very upset

6. If the public schools in your community taught both the theory of evolution and creationism, how upset would you be?

1 2 3 4 5
Not at all upset Somewhat upset Very upset

7. If the public schools in your community taught the theory of evolution—that is, the idea that human beings evolved from other species of animals—how pleased would you be?

1 2 3 4 5
Not at all pleased Somewhat pleased Very pleased

8. If the public schools in your community taught the theory of creationism—that is, the idea that human beings were created by God in their present form and did not evolve from other species of animals—how pleased would you be?

1	2	3	4	5
Not at all pleased		Somewhat pleased		Very pleased

9. If the public schools in your community taught both the theory of evolution and creationism, how pleased would you be?

1	2	3	4	5
Not at all pleased		Somewhat pleased		Very pleased

APPENDIX C

ACCEPTANCE OF EVOLUTION

For the following items, please indicate your agreement / disagreement with the given statements using the following scale:

A	B	C	D	E
Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

1. Organisms existing today are the result of evolutionary processes that have occurred over millions of years.
2. The theory of evolution is incapable of being scientifically tested. (r)
3. Modern humans are the product of evolutionary processes which have occurred over millions of years.
4. The theory of evolution is based on speculation and not valid scientific observation and testing. (r)
5. Most scientists accept evolutionary theory to be a scientifically valid theory.
6. The available data are ambiguous as to whether evolution actually occurs. (r)
7. The age of the earth is less than 20,000 years. (r)
8. There is a significant body of data which supports evolutionary theory.
9. Organisms exist today in essentially the same form in which they always have. (r)
10. Evolution is not a scientifically valid theory. (r)
11. The age of the earth is at least 4 billion years.
12. Current evolutionary theory is the result of sound scientific research and methodology.
13. Evolutionary theory generates testable predictions with respect to the characteristics of life.
14. The theory of evolution cannot be correct since it disagrees with the biblical account of creation. (r)
15. Humans exist today in essentially the same form as in which they always have. (r)
16. Evolutionary theory is supported by factual, historical, and laboratory data.
17. Much of the scientific community doubts if evolution occurs. (r)
18. The theory of evolution brings meaning to the diverse characteristics and behaviors observed in living forms.
19. With few exceptions, organisms on earth came into existence at about the same time. (r)
20. Evolution is a scientifically valid theory.

APPENDIX D

ORIGIN BELIEFS AND CONFIDENCE IN OWN POSITION

1. Some people think that humans and other living things have evolved over time. Others think that humans and other living things have existed in their present form since the beginning of time. Which of these comes closest to your view?

a. All life, including humans, evolved over millions of years through completely natural processes such as natural selection.
b. All life, including humans, evolved over millions of years, but this process was guided by a supreme being.
c. All life, including humans, was created by a supreme being pretty much in its present form at one time within the last 10,000 years or so.

2. You have selected [a, b, or c]. How confident are you that [a, b, c] is true?

1	2	3	4	5	6	7
Not at all confident		Somewhat confident			Very confident	

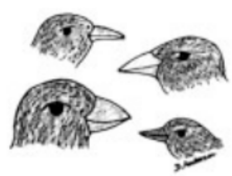
APPENDIX E

KNOWLEDGE OF EVOLUTION

Conceptual Inventory of Natural Selection

D.L. Anderson and K.M. Fisher

Your answers to these questions will assess your understanding of the Theory of Natural Selection. Please choose the answer that best reflects how a biologist would think about each question.



Galapagos finches

Scientists have long believed that the 14 species of finches on the Galapagos Islands evolved from a single species of finch that migrated to the islands one to five million years ago (Lack, 1940). Recent DNA analyses support the conclusion that all of the Galapagos finches evolved from the warbler finch (Grant, Grant & Petren, 2001; Petren, Grant & Grant,, 1999). Different species live on different islands. For example, the medium ground finch and the cactus finch live on one island. The large cactus finch occupies another island. One of the major changes in the finches is in their beak sizes and shapes, as shown in this figure.

Choose the one answer that best reflects how an evolutionary biologist would answer.

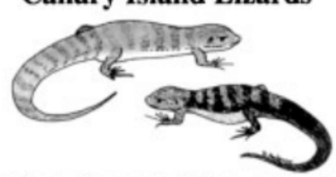
FIGURE 1

1. What would happen if a breeding pair of finches was placed on an island under ideal conditions with no predators and unlimited food so that all individuals survived? Given enough time…
   a. the finch population would stay small because birds only have enough babies to replace themselves.
   b. the finch population would double and then stay relatively stable.
   c. the finch population would increase dramatically.
   d. the finch population would grow slowly then level off.
2. Finches on the Galapagos Islands require food to eat and water to drink.
   a. When food and water are scarce, some birds may be unable to obtain what they need to survive.
   b. When food and water are limited, the finches will find other food sources, so there is always enough.
   c. When food and water are scarce, the finches all eat and drink less so that all birds survive.
   d. There is always plenty of food and water on the Galapagos Islands to meet the finches' needs.
3. Depending on their beak size and shape, some finches get nectar from flowers, some eat grubs from bark, some eat small seeds, and some eat large nuts. Which statement best describes the interactions among the finches and the food supply?

a. Most of the finches on an island cooperate to find food and share what they find.
b. Many of the finches on an island fight with one another and the physically strongest ones win.
c. There is more than enough food to meet all the finches' needs so they don't need to compete for food.
d. Finches compete primarily with closely related finches that eat the same kinds of food, and some may die from lack of food.

4. How did the different beak types <u>first</u> arise in the Galapagos finches?
    a. The changes in the finches' beak size and shape occurred because of their need to be able to eat different kinds of food to survive.
    b. Changes in the finches' beak occurred by chance, and when there was a good match between beak structure and available food, those birds had more offspring.
    c. The changes in the finches' beaks occurred because the environment induced the desired genetic changes.
    d. The finches' beaks changed a little bit in size and shape with each successive generation, some getting larger and some getting smaller.
5. What type of variation in finches is passed to the offspring?
    a. Any behaviors that were learned during a finch's lifetime
    b. Only characteristics that were beneficial during a finch's lifetime
    c. All characteristics that are genetically determined
    d. Any characteristics that were positively influenced by the environment during a finch's lifetime

Canary Island Lizards



The Canary Islands are seven islands just west of the African continent. The islands gradually became colonized with life: plants, lizards, birds, etc. Three different species of lizards found on the islands are similar to one species found on the African continent (Thorpe & Brown, 1989). Because of this, scientists assume that the lizards traveled from Africa to the Canary Islands by floating on tree trunks washed out to sea.

Choose the one answer that best reflects how an evolutionary biologist would answer.

FIGURE 2

6. Lizards eat a variety of insects and plants. Which statement describes the availability of food for lizards on the canary islands?
    a. Finding food is not a problem since food is always in abundant supply.
    b. Since lizards can eat a variety of foods, there is likely to be enough food for all the lizards at all times.
    c. Lizards can get by on very little food, so the food supply does not matter.
    d. It is likely that sometimes there is enough food, but at other times there is not enough food for all of the lizards

7. What do you think happens among the lizards of a certain species when the food supply is limited?
    a. The lizards cooperate to find food and share what they find.
    b. The lizards fight for the available food and the strongest lizards kill the weaker ones.
    c. Genetic changes that would allow lizards to eat new food sources are likely to be induced.
    d. The lizards least successful in the competition for food are likely to die of starvation and malnutrition.
8. Which statement could describe how traits in lizards pass from one generation of lizards to the next?
    a. Lizards that learn to catch a particular type of insect will pass the new ability to offspring.
    b. Lizards that are able to hear, but have no survival advantage because of hearing, will eventually stop passing on the "hearing" trait.
    c. Lizards with stronger claws that allow for catching certain insects have offspring whose claws gradually get even stronger during their lifetime.
    d. Lizards with a particular coloration and pattern are likely to pass the same trait on to offspring.
9. Fitness is a term often used by biologists to explain the evolutionary success of certain organisms. Below are descriptions of four fictional female lizards. Which lizard might a biologist consider to be the "most fit"?

	Lizard A	Lizard B	Lizard C	Lizard D
Body length	20 cm	12 cm	10 cm	15 cm
Offspring surviving to adulthood	19	28	22	26
Age at death	4 years	5 years	4 years	6 years
Comments	Lizard A is very healthy, strong, and clever	Lizard B has mated with many lizards	Lizard C is dark colored and very quick	Lizard D has the largest territory of all the lizards

FIGURE 3

    a. Lizard A
    b. Lizard B
    c. Lizard C
    d. Lizard D

10. According to the theory of natural selection, where did the variations in body size in the three species of lizards most likely come from?
    a. The lizards needed to change in order to survive, so beneficial new traits developed.
    b. The lizards wanted to become different in body size, so beneficial new traits gradually appeared in the population.
    c. Random genetic changes and sexual recombination both created new variations.
    d. The island environment caused genetic changes in the lizards.

Questions 11 and 12: Consider the figure and passage below and answer the questions that follow.
Consider the proposed evolutionary tree below. Mammals originated on land, yet whales are adapted to life in the sea and can never come onto the land. The exact process of how land animals evolved into whales has been difficult to understand. However, new discoveries in India, Afghanistan and Pakistan are providing evidence for the transition of the whale family from ancient shore-dwelling ancestors.

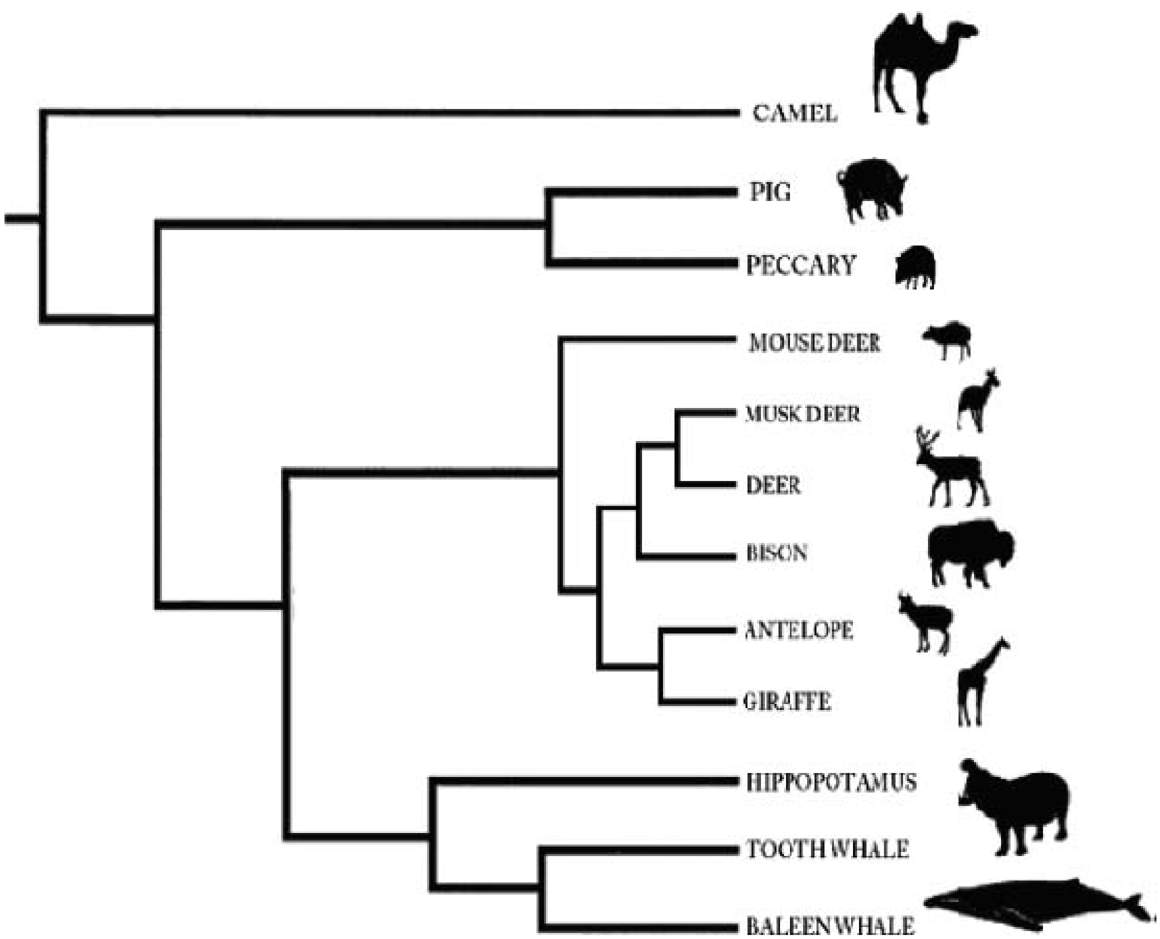


FIGURE 4

11. The fossils that are being examined to determine the ancestor in the evolutionary pathway of whales have been found in areas of Pakistan, Afghanistan, and India, places that are now well above sea level. The most scientifically reasonable explanation for the location of the fossils being examined is:
    a. Predators of whale ancestors carried their prey to this area to eat them.
    b. When the whales died their skeletons floated to the top of the ocean where they drifted ashore and became fossils.
    c. This area was most likely once covered with water and the shore dwelling ancestors of whales once lived in these areas, died, and their skeletons were fossilized.
    d. The great meteor impact caused tidal wave that forced these animals into these areas trapping them causing them to die, and their skeletons were fossilized.

12. The evolutionary history and development of whales has been hotly debated. Recently there has been a major shift in our understanding of the processes used to detail whale evolution. This indicates that:
    a. Gaps in the fossil records will never allow us to fully understand evolution.
    b. Scientists studying evolution typically present ideas with very little evidence, leaving it to others to find proof of their ideas.
    c. Aspects of evolution are constantly being challenged and explored in light of new evidence.
    d. Much of the science of evolution is based on speculation that can easily be changed when scientists think of new ideas.

Questions 13–15: Consider the two figures and passage below and answer the questions that follow.
The evolution of the eye has been studied extensively. It is a good example of an organ that at present has a wide range of forms in a wide variety of species (see Figure 2). Most experts think that all modern eyes have their origins dating back some 540 million years. An examination of the density of photoreceptors of the pigment cup and the complex eye reveal a variation within species as well as between species. The plots of the relative density of photoreceptors of the present day Nautilus and Octopus are presented in Figure 3.

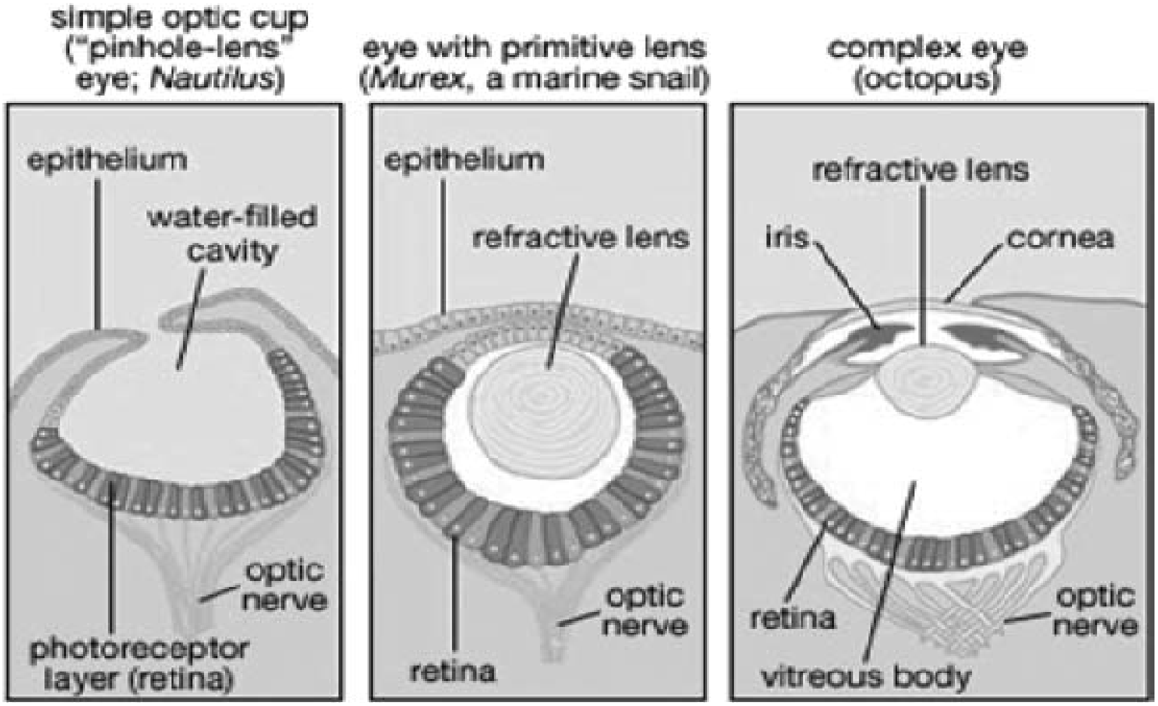


FIGURE 5 The different levels of eye complexity in mollusks.

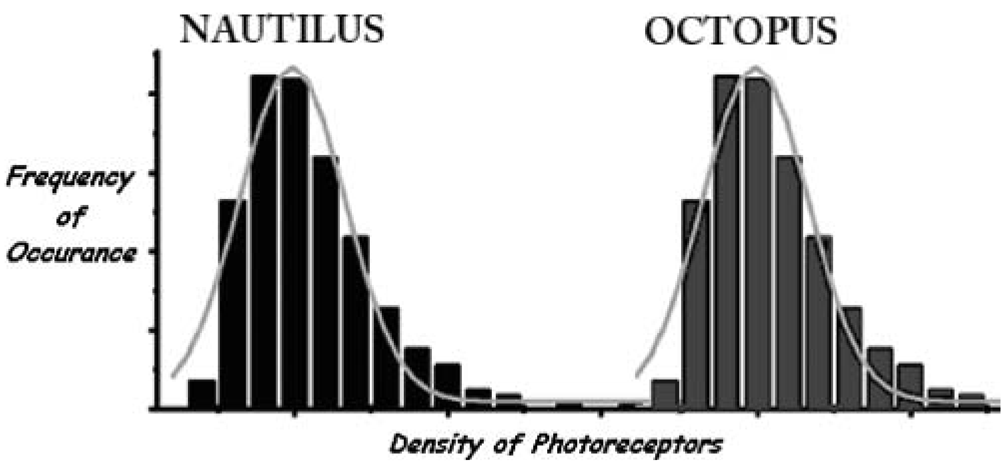


FIGURE 6 Variation in the relative density of photoreceptors in nautilus and octopus eyes.

13. Most vertebrate fossils are the bones of these ancient organisms, and it is unlikely that we will find fossils of their eyes. This is because:
    a. Animals close their eyes when they die and the eyes are buried under layers of fossils.
    b. Primitive eyes were so small that they are easily overlooked as fossils.
    c. Primitive eyes were so different that scientists are not looking for the right structures.
    d. Eye tissue typically decays before it can form fossils.

14. There is a variation in the number and density of photoreceptors in the eyes (see Figure 3) within a population. This is an important consideration when trying to understand evolution because:
    a. Some individuals in a population are trying harder to see better than others.
    b. The variation in eye structure within a population can lead to the development of new eye structures.
    c. There are variations happening within all populations and they have no evolutionary significance.
    d. Variations indicate a species is no longer evolving but now stabilized.

15. Evidence for the evolution of the eye is based primarily on the observations of organisms alive today. This means:
    a. Since present day animals have all developed very complex eyes, useful inferences about changes in primitive eyes are very difficult to make.
    b. Scientists must assume that the eyes of organisms today are the same as their extinct ancestors.
    c. Eyes are a recent development, evolutionarily speaking, and scientist cannot understand the structure of the eyes in the past based on evidence of eyes today.
    d. The structure of the eyes in some organisms today support scientists' views of how eyes developed over time.

Questions 16–17: Consider the figure and passage below and answer the questions that follow.

Extinction is extremely important in the history of life. It can be a frequent or rare event within a lineage. Every lineage has some chance of becoming extinct. Over 99% of the species that have ever lived on Earth have gone extinct. Figure 4 illustrates the evolution lineages of several animal species.

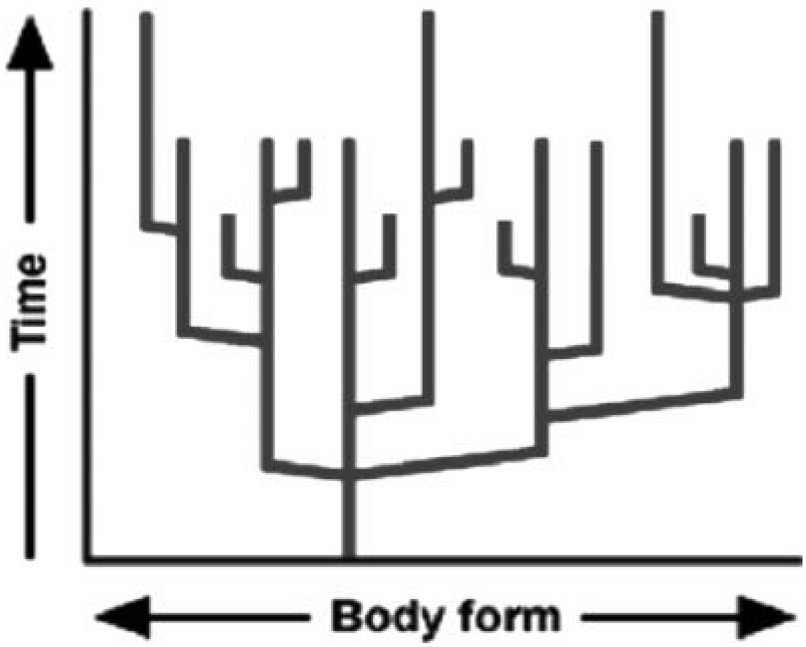


FIGURE 7 The historical development of the lineages of several animal species.

16. The diagram above indicates that all of the organisms originated from the same:
    a. Kingdom.
    b. Relatives.
    c. Location on the planet.
    d. Ancestor.

17. The formation of branching diagrams like the one presented above is based on:
    a. Common names of the organisms.
    b. Genes and body structures.
    c. Habitat in which modern organisms are now naturally found.
    d. Elevation and location in which the ancient fossils were discovered.

Questions 18-19: Consider the figure and passage below and answer the questions that follow.

The graphic below is a suggested evolutionary pathway of the African Great Apes. The arrangement of this pathway is based on genetic information taken from the mitochondria of the various apes.

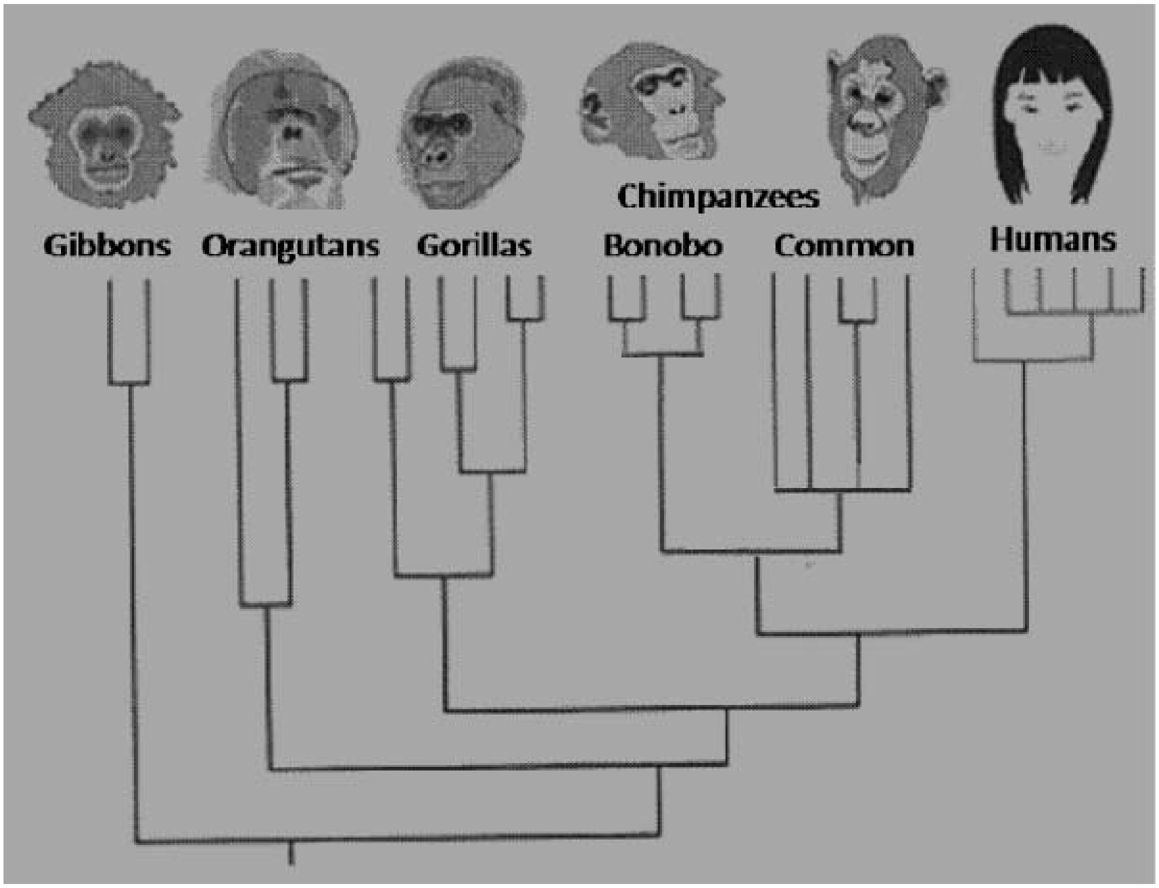


FIGURE 8 A hypothesized evolutionary lineages of the African Great Apes

18. The diagram above suggests that:
    a. Orangutans include the most recently evolved species and Gibbons are the most ancient species of apes.
    b. There has always been at least 5 species of Great Apes.
    c. Gorillas represent the most diverse of the different groups of Great Apes.
    a. Humans and Chimpanzees share a more recent common ancestor than Gibbons and Orangutans.

19. In advanced discussions of the evolution of the Great Apes, one will see a number of different evolutionary pathways, each suggesting a different relationship between the different groups of Apes. These discrepancies suggest:
    a. Scientists remain uncertain if any of the Great Apes are really related and are continuing to try to prove this.
    b. Scientists remain uncertain why humans would want to evolve and are continued to be seen as the superior species.
    c. Anything aside from fossils is a weak form of evidence for the support of evolutionary theory.

d. Processes and small differences in methods can produce very different evidence that can be interpreted in different ways.

Question 20: Consider the figure and passage below and answer the questions that follow.

The graphic below is a map depicting where the fossils of various organisms have been found on different continents. This map also depicts our best understanding of the relative position of some of the continents in the earth's early history.

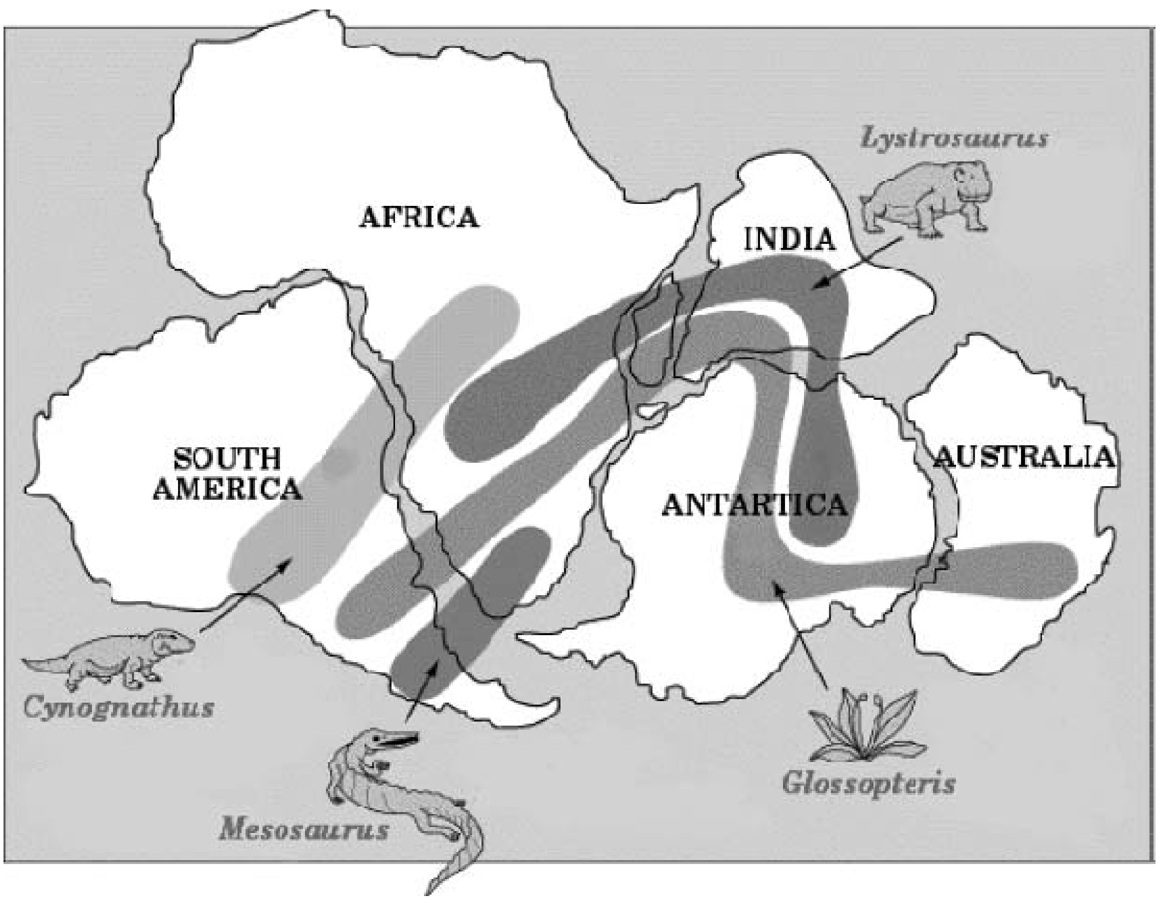


FIGURE 9 The distribution of fossils for 4 species across today's continents. The map shows how the continents may have once been located.

20. If a similar fossil was found on different continents, scientists might infer that:
    a. The continents involved were once connected.
    b. Eventually, the organisms will want to spread out and will be found on every continent.
    c. They must have come from different species but all look the same.
    d. The organisms were aware enough to know it was vital to move between continents.

APPENDIX F

RELIGIOSITY

1. How religious would you say you are?

1	2	3	4	5	6	7	8	9	10
Not at	all								Extremely

2. How important is religion in your life?

1	2	3	4	5	6	7	8	9	10
Not at	all								Extremely

3. How often do you pray?

1	2	3	4	5	6	7	8	9	10
Never									Extremely often

4. How often do you go to church?

1	2	3	4	5	6	7	8	9	10
Never									Extremely often

5. What is your religious affiliation?
   a. Evangelical Protestant
   b. Mainline Protestant
   c. Catholic
   d. Mormon
   e. Other Christian
   f. Jewish
   g. Buddhist
   h. Muslim
   i. Atheist
   j. Agnostic
   k. Other

APPENDIX G

POLITICAL IDEOLOGY

Please indicate your political ideology:

1	2	3	4	5	6	7
Extremely Conservative			Moderate			Extremely Liberal

Please report your party identification:

a. Strong Democrat
b. Moderate Democrat
c. Independent Democrat
d. Independent
e. Independent Republican
f. Moderate Republican
g. Strong Republican

APPENDIX H

SCIENTIFIC TOLERANCE

Which ONE of the following statements do you DISAGREE with MOST?
(It is OK if you disagree with more than one item. Please select the item you disagree with MOST of all)

1. Embryonic stem cell research is worthwhile
2. Embryonic stem cell research is worthless
3. Climate change is influenced by human activity
4. Climate change is NOT occurring
5. There is NO connection between HIV and AIDS
6. Genetically modified foods (GMO's) are safe to eat
7. Genetically modified foods (GMO's) are dangerous to eat
8. Sexual orientation is a choice
9. Sexual orientation is genetically determined
10. Nuclear power should NOT be used as a source of energy
11. Nuclear power should be used as a source of energy
12. The Measles, Mumps and Rubella (MMR) vaccine causes autism
13. The Measles, Mumps and Rubella (MMR) vaccine does not cause autism
14. I prefer not to respond.

You have selected the statement "[Q1]." Just to be sure, is it correct that you DISAGREE MOST that "[Q1]?" (If not, please go back to the previous question).

We are interested in the attitudes and opinions of people concerning issues in science. On the following pages, you will find a series of statements. Please read each statement and indicate your agreement or disagreement by choosing a number along the scale below. Note that the scale ranges from 1(disagree strongly) to 7(agree strongly). Please choose the number on the scale that best represents your opinion.

1. *Someone who believes that [Q1] should NOT be hired as a high school science teacher.
2. People who believe that [Q1] should be allowed to use public college campuses to hand out pamphlets expressing their views.
3. People who believe that [Q1] should be allowed to publish their opinions in scientific journals.
4. *Public school science teachers who believe that [Q1] should NOT express these views in class.
5. *Public schools should NOT purchase textbooks arguing that [Q1].
6. *A teacher who believes that [Q1] should NOT be appointed chair of their science department.
7. People who argue that [Q1] should be invited to speak at science conferences.
8. Groups arguing that [Q1] should be allowed to hold meetings on college campuses to express their views.
9. *Colleges should NOT spend money for speakers who argue that [Q1].
10. *Research grants should NOT be awarded to people who believe that [Q1].

APPENDIX I

DEMOGRAPHIC

1. What is your age?
2. What is your gender?
3. What is your major? (Open-ended)
4. What is your ethnicity? (Open-ended)

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VITA

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